§42. Response of Magnetic Island to Localized Electron Cyclotron Heating

Isayama, A. (JAEA), Inagaki, S. (Kyushu Univ.), Sakakibara, S., Kubo, S.

Various behavior of magnetic island, such as spontaneous growth or suppression, has been observed in LHD experiments. It is also observed plasma performance is affected by magnetic island. The aim of this study is to investigate the response of magnetic island to external perturbations and compare with magnetic island observed in JT-60U. In this experimental campaign, the effect of localized heating in the island region by electron cyclotron heating (ECH) has been investigated.

In this series of experiments, the toroidal field is 2.75 T, the location of magnetic axis is 3.6 m, and the current of the local island divertor (LID) is 1.5 kA. An 82.7 GHz electron cyclotron (EC) wave was injected from the 9.5U port or the 5.5U port for ECH to the island O-point or X-point, respectively. An 77 GHz modulated ECH (MECH) with the modulation frequency of 29 Hz was injected to estimate magnetic island width by measuring heat wave propagation using electron cyclotron emission (ECE) diagnostic. In these discharges, direction of neutral beam (NB) was switched over before ECH to obtain larger magnetic island.

Phase profile of electron temperature perturbation is shown in Fig. 1(a), where the 82.7 GHz ECH is deposited at the island O-point. Deposition location calculated a ray tracing code is (R_{dep}, Z_{dep})=(3.494 m, 0.25 m). As shown with open circles, a clear W-shaped profile is observed before the 82.7 GHz ECH, which is thought to be a result of reduced transport inside the magnetic island. The local maximum point at ρ~0.3 corresponds to the island center, and the two local minimum points at ρ~0.2 and 0.5 correspond to the edge of the magnetic island. Thus, the full island width is estimated to be about 0.3 in ρ. Here, ρ is normalized minor radius. After the 82.7 GHz ECH, shrinkage of the island width was observed as shown with the closed circles in Fig. 1. Phase profiles for 82.7 GHz ECH at (R_{dep}, Z_{dep})=(3.534 m, 0.25 m) and (3.574 m, 0.25 m), which corresponds to +4 cm (#77861) and +8 cm (#77864) deviation of the deposition location compared with shot #77860, are shown in Fig. 1(b) and (c), respectively. While similar shrinkage is observed for the former case, no clear shrinkage is not observed for the latter case, which suggests that the shrinkage is caused by the 82.7 GHz ECH, and the shrinkage effect is weakened when the island heating is not effective.

Figure 2 shows electron temperature profile measured with Thomson scattering before and after the 82.7 GHz ECH. As shown in this figure, a flat region is observed at R~3.0 m, suggesting the island formation. In shots #77860 and #77861, the flat region becomes unclear and at the same time the central electron temperature increases. On the other hand, the island structure is almost unchanged in shot #77864. This result is consistent with the phase profile analysis in Fig. 1.

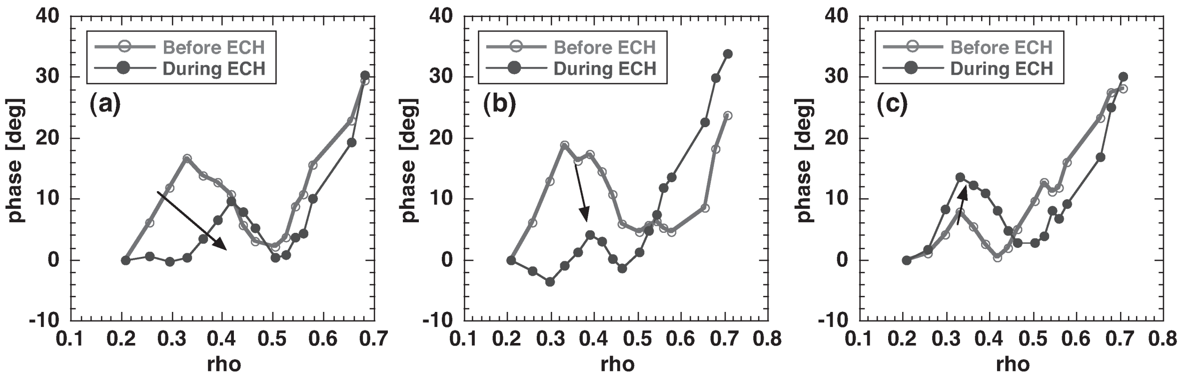

Fig. 1: Phase profiles before ECH (open circles) and during ECH (closed circles).
(a) (R_{dep}, Z_{dep})=(3.494 m, 0.25 m), (b) (R_{dep}, Z_{dep})=(3.534 m, 0.25 m), (c) (R_{dep}, Z_{dep})=(3.574 m, 0.25 m).

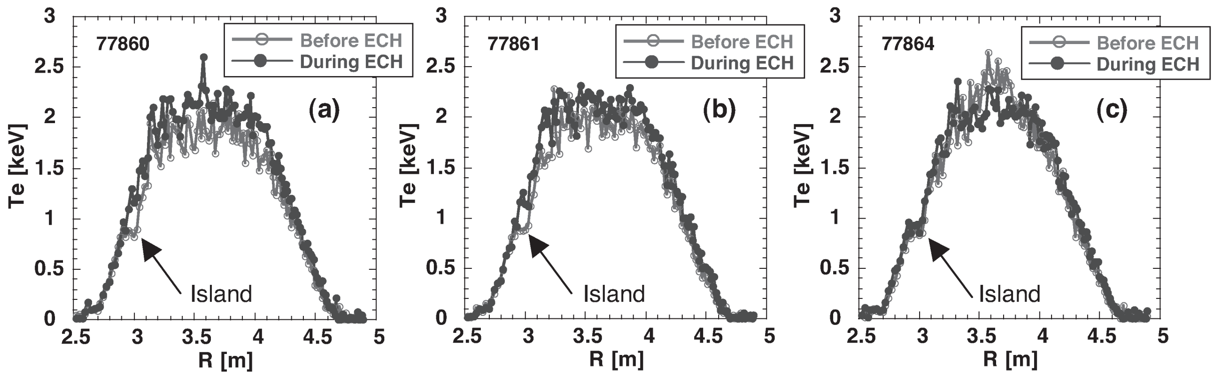

Fig. 2: Electron temperature profiles before ECH (open circles) and during ECH (closed circles).
(a) (R_{dep}, Z_{dep})=(3.494 m, 0.25 m), (b) (R_{dep}, Z_{dep})=(3.534 m, 0.25 m), (c) (R_{dep}, Z_{dep})=(3.574 m, 0.25 m).